

CRITERION 410

FANS AND DUCTWORK

SIGNATURES



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CRITERION 410

FANS AND DUCTWORK

1.0 PURPOSE

The purpose of this Criterion is to establish the minimum requirements and best practices for operation and maintenance of fans and assorted ductwork at LANL.

This document addresses the requirements of LIR 230-05-01(Ref 10.1), "Operations and Maintenance Manual."

Implementation of this Criterion satisfies DOE Order 430.1A (Ref 10.18) for the subject equipment / system. DOE Order 430.1A "Life Cycle Asset Management," "Contractor Requirements Document," Paragraph 2, Sections a through c, which in part requires UC to "...maintain physical assets in a condition suitable for their intended purpose," and employ "preventive, predictive, and corrective maintenance to ensure physical asset availability for planned use and/or proper disposition." Compliance with DOE Order 430.1A is required by Appendix G of the UC Contract.

2.0 SCOPE

The scope of this Criterion addresses operation and maintenance of fans and duct systems for building air supply/exhaust and industrial/process ventilation. Fan types include axial flow, centrifugal and propeller type roof ventilators. Duct systems include dampers and drip pans. Heating and cooling supply systems (coils, boilers, chillers, compressors, steam traps and pressure reducing valves (PRVS) are not part of this criterion. Filters are also not covered under this criterion.

3.0 ACRONYMS AND DEFINITIONS

3.1 Acronyms

AHJ	Authority Having Jurisdiction
AMCA	Air Movement and Control Association. Inc.
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers.
CMMS	Computerized Maintenance Management System
IAQ	Indoor Air Quality
JCNNM	Johnson Control Northern New Mexico
ML	Management Level

POC	Point of Contact
PP&PE	Personal Property and Programmatic Equipment
PPE	Protective Personal Equipment
PRVs	Pressure Regulating Valves
RP&IE	Real Property and Installed Equipment
SSC	Structures, Systems, and Components

3.2 Definitions

Acceptable Indoor Air Quality. Air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people do not express dissatisfaction. (Reference 10.4)

Damper. Device used to control the volume of airflow or isolate airflow.

Dry Section. The section of the Air Handling Unit that includes filters, fans, mixing section of the system, and provides access doors to these accessories.

Duct. A fluid flow passage, which may range from a few inches in diameter to many feet in rectangular cross section, usually constructed of galvanized steel, aluminum, or copper, through which air flows in a ventilation system.

Fan. A device usually consisting of a rotating paddle wheel or air screw, with or without a casing for producing currents in order to circulate, exhaust or deliver large volumes of air or gas.

Pressure Regulating Valves. A valve that releases or holds process-system pressure (that is, opens or closes) either by preset spring or by actuation by a valve controller to assume any desired position between full open and full closed.

Wet Section. Any section of the unit that includes water running through it such as coils.

4.0 RESPONSIBILITIES

4.1 FWO-Systems, Engineering and Maintenance (SEM)

- 4.1.1** FWO-SEM is responsible for the technical content of this Criterion and monitoring the applicability and the implementation status of this Criteria and either assisting the organizations that are not applying or meeting the implementation expectations contained herein or elevating their concerns to the director(s).

Basis: LIR 301-00-01.11; Issuing and Managing Laboratory Operations Implementation Requirements and Guidance, Section 5.4, OIC Implementation Requirements.

4.1.2 FWO-SEM shall provide technical assistance to support implementation of this Criterion.

4.2 Facility Manager

4.2.1 Responsible for operations and maintenance of institutional, or Real Property and Installed Equipment (RP&IE) under their jurisdiction, in accordance with the requirements of this document.

4.2.2 Responsible for operations and maintenance of those Personal Property and Programmatic Equipment (PP&PE) systems and equipment addressed by this document that may be assigned to the FM in accordance with the FMU-specific Facility/Tenant Agreement.

4.3 Group Leader

4.3.1 Responsible for operations and maintenance of those Personal Property and Programmatic Equipment (PP&PE) systems and equipment addressed by this document that are under their jurisdiction

4.3.2 Responsible for system performance analysis and subsequent replacement or refurbishment of assigned PP&PE.

4.4 Authority Having Jurisdiction (AHJ) - POC for Mechanical Chapter of LANL Engineering Manual

4.4.1 The AHJ is responsible for providing a decision on a specific technical question regarding national, state and local codes and DOE orders

5.0 PRECAUTIONS AND LIMITATIONS

5.1 Precautions

This section is not intended to identify all applicable precautions necessary for implementation of this Criterion. A compilation of all applicable precautions shall be contained in the implementing procedure(s) or work control authorization documents. The following precautions are intended only to assist the author of a procedure or work control document in the identification of hazards/precautions that may not be immediately obvious.

- 5.1.1** Provide work packages with manufacturers recommendations and/or the desired type of lubricant to use for fan bearings. Proper lubrication is vitally important in maintaining trouble-free operation and avoiding equipment damage.
- Basis:* Lessons Learned Operating Experience Weekly Summary 98-06 (Reference 10.5) inadequate maintenance procedures could have resulted in the failure of an exhaust fan bearing.
- 5.1.2** Ensure motion hazard machine guards are in place prior to operation.
- 5.1.3** Fans can “windmill” due to air currents despite being de-energized. Blades need to be clamped or tied off.
- Basis:* OSHA Regulations 29 CFR 1910.212 (Reference 10.1). Compliance with these standards is required per Appendix G of the UC Contract (Reference 10.17). Lessons Learned Database, Personal Injury in Air Handling Unit. Identifier: 1998-CH-AMES-0001(Reference 10.2).
- 5.1.4** Do not operate centrifugal fans with forward incline blades with discharge damper closed as the motor may overheat.
- 5.1.5** Follow proper Lockout/Tagout procedures when necessary.

5.2 Limitations

The intent of this Criterion is to identify the minimum generic requirements and recommendations for SSC operation and maintenance across the Laboratory. Each user is responsible for the identification and implementation of additional facility specific requirements and recommendations based on their authorization basis and unique equipment and conditions, (e.g., equipment history, manufacturer warranties, operating environment, vendor O&M requirements and guidance, etc.). Nuclear facilities and moderate to high hazard non-nuclear facilities will typically have additional facility-specific requirements beyond those presented in this Criterion.

Nuclear facilities shall implement the requirements of DOE Order 4330.4B (Ref. 10.15) (or 10 CFR 830.340, Maintenance Management) as the minimum programmatic requirements for a maintenance program. Additional requirements and recommendations for SSC operation and maintenance may be necessary to fully comply with the current DOE Order or CFR identified above.

6.0 REQUIREMENTS

Minimum requirements that Criterion users shall follow are specified in this section. Requested variances to these requirements shall be prepared and submitted to FWO-SEM in accordance with LIR 301-00-02 (Ref. 10.16), “Variances and Exceptions to

Laboratory Operations Requirements,” for review and approval. The Criterion users are responsible for analysis of operational performance and SSC replacement or refurbishment based on this analysis. Laws, codes, contractual requirements, engineering judgement, safety matters, and operations and maintenance experience drive the requirements contained in this section.

6.1 Operations Requirements

6.1.1 No requirements identified.

6.2 Maintenance Requirements

6.2.1 No requirements identified

7.0 RECOMMENDATIONS AND GOOD PRACTICES

The information provided in this section is recommended based on acceptable industry practices and should be implemented by each user based on his/her unique application and operating history of the subject systems/equipment.

7.1 Operations Recommendations

7.1.1 Start-up

7.1.1.1 Utilize start up procedures prior to operating a fan for initial start up, or after maintenance:

- Electrically isolate and lockout fan.
- Ensure starting torque is adequate for the speed and inertia of the fan.
- Inspect fan and ducts for debris that could be sucked into fan or dislodged.
- Check dampers for correct configuration.
- Turn fan impeller or wheel by hand to check for binding.
- Check belt tension and drive installation.
- Verify alignment on direct drive fans.
- Check that all nuts, belts, and setscrews are tight.
- Check for correct voltage supply and correct rotation.
- Upon startup, check for excessive vibration, unusual noises.
- Verify unusual design speed with a strobe light.

Basis: Pre start checks and procedure will prevent fan damage and contribute to maximum efficiency and long life.

7.2 Maintenance Recommendations

7.2.1 Preventive Maintenance Instructions For Fan and Duct Systems

7.2.1.1 Monthly

7.2.1.1.1 Perform the following inspections on Air Handling Unit section:

- Check fan flexible duct connections for rupture or leaks and repair as needed.
- Check fan, bearings, and belts for excessive vibration or noise and take vibration readings as necessary.
- Check fan-bearing lubrication including over-lubricating.

Basis: Periodic inspections and documentation will provide early detection of impending component failure and will allow for trending analysis. Experience shows that impending failure of moving equipment is usually preceded by unusual noise.

7.2.1.2 Semi-annually (Every 6 Months)

7.2.1.2.1 Perform the following inspections on the Air Handling Unit section:

- Shut unit down to check the belt drive; check belts for wear, proper tension, and sheave alignment and adjust as necessary; belts should be tensioned to the belt manufacturers recommendations. Check sheaves for abnormal wear; if belts need to be replaced, replace them using matched sets and check to see if sheaves, fan wheel, and bearing collars are securely fastened to the shaft. Check for signs of fretting corrosion (reddish brown powder rust) iron oxide. See Appendix B for additional information.
- Lubricate fan bearings per manufacturers recommendations. Frequency dependent on type of fan and manufacturer.
- Check motor bearing lubrication and lubricate per manufacturers recommendations and Criterion 510.
- Visually check alignment of fan and motor sheaves. Obtain manufacturers literature and/or recommendations for proper alignment procedures.
- Check for free movement of vibration isolators and vibration of fan.
- Fan sections of air handlers should be inspected semi-annually at a minimum or more frequently if operating experience dictates. Accumulated dirt and organic

matter on the interior surfaces of fan(s) should be cleaned immediately. Follow manufacturers guidelines.

Basis: Periodic inspections and documentation will provide early detection of impending component failure and will allow for trending analysis. Many of these practices are recommended in the AMCA Publication 202-88 Fan Application Manual (Reference 10.3) and the SMACNA Building Systems Analysis and Retrofit Manual (Reference 10.14).

7.2.1.2.2 Perform the following inspection on the “Wet” and “Dry” Sections of the Air Handling unit:

- Inspect the internal insulation of air handling units in the “wet” section of units to assure that the insulation is clean and free of dirt and microbial growth (mold). Areas of the unit, which are normally considered to be “dry”, must also be inspected to assure that the insulation is clean and dry. Check condition of gasketing and insulation around unit, door, and dampers and repair or replace as necessary.

Basis: Operating experience at LANL and manufacturers literature indicates that regular visual inspection of key air handling system accessories will help minimize personnel health and safety concerns. Accumulated dirt and other organic matter exposed to water or extended periods of high relative humidity (60% or higher) can support microbial growth, which must be removed to prevent the unit from becoming an IAQ contaminant source.

7.2.1.2.3 Perform the following inspections on the Drain Pan section:

- Inspect and clean drain pans. Biofilms, slimes, and fungal growth found in drain pans and other adjacent surfaces should be physically removed immediately.
- Check condensate drain pan and drain line to assure condensate drains completely. Remove sludge or foreign materials that might obstruct proper drainage, remove obstacles.
- For units with sloped drain pans, if evidence of standing water or condensate overflow exists, refer to troubleshooting section of manufacturers manual for possible causes and solutions or contact manufacturer.

Basis: Manufacturers literature and operating experience indicates that the recommended maintenance of components will ensure efficient and reliable air handling unit operation and reduce personnel health and safety concerns. Some of these practices are recommended in the SMACNA Building Systems Analysis and Retrofit Manual (Reference 10.14)

7.2.1.3 Annually**7.2.1.3.1** Perform the following inspections on the Air Handling Unit section:

- Check fan wheel and shaft for materials buildup and excessive or unusual wear and clean as required.
- Rotate the fan wheel and check for obstructions in the fan housing. Wheel should not rub on the fan housing. Adjust the center if necessary and tighten the wheel. Tighten setscrews to the proper torque.
- Check fan bearing grease line connection. Lines should be leak tight from the zerk fitting to the bearings.
- Check bearing and motor bracket bolt torque.
- Inspect the unit casing for corrosion.
- Check the flow surfaces (passages between the inlets, especially impeller blades and inside of housing) for cleanliness. One-sixteenth inch buildup of dirt on the flow surfaces will impair fan performance.
- Check for any gouges, tears, holes, erosion or corrosion in the impeller blades, rims, backplate, inlets and housing. If so, report the approximate size and location to the fan manufacturer for recommendations.
- Check for any foreign matter trapped in the impeller, housing, or ductwork (loose insulation, papers, etc.). If present remove.

Basis: Operating experience and manufacturer's literature has shown that fan performance can deteriorate over time due to wear and tear of equipment.

Many of these practices are recommended in the AMCA Publication 202-98 Fan Application Manual (Reference 10.3).

7.2.1.3.2 Perform the following inspections on the ductwork section of the Air Handling System.

- Inspect outside duct systems for corrosion and weather damage.
- For all actuated type dampers, visually check operation of damper, check for full closure, check edge and blade seals for wear and deterioration, visually inspect dampers and ductwork for any obstructing materials.
- For all heavy-duty industrial dampers, visually check and grease/lube bearings if necessary according to manufacturers recommendations.
- Outdoor air intake louvers, bird screens and adjacent areas should be visually inspected for cleanliness and integrity and cleaned as needed.

- On systems with pneumatic and electric controls, check for loose or inoperative linkages on dampers and inlet guide vanes and repair as required.
- Check damper linkage set screws and blade adjustment. Follow manufacturer's guidelines for procedures or contact manufacturer.
- Check seals of isolation dampers.

Basis: Annual walk down of ductwork systems allows better performance of the overall air handling system. Conversation with vendors agrees with recommendations. Some of these practices are recommended in the SMACNA Building Systems Analysis and Retrofit Manual (Reference 10.14, Section 8.3.1.2).

7.2.1.4 Bi-annually(Every 2 Years)

7.2.1.4.1 Perform the following inspections on the ductwork sections of the air handling system:

- Supply and return air plenum systems, (ceilings, rooms, raised floors, etc.) should be visually inspected in representative locations for cleanliness (e.g., excessive accumulated dust and debris) openings that compromise the integrity of the plenum, obstructions that block air paths, water damage, microbial growth, and hazardous materials (such as rodent poisons) and the findings brought to the attention of the Facility Manager. Repair as needed.

Basis: Recommended practice per ASHRAE Standard 62-1999 Ventilation for Acceptable Indoor Air Quality (Reference 10.4) Public Review Draft August 1996.

7.2.1.5 Every 5 Years

7.2.1.5.1 Perform the following measurements for the entire air handling system:

- The total quantity of supply air, exhaust air, and outdoor air from the air handling systems (not including unit ventilators, induction units, or small fan coil units under 2000 CFM) should be measured at airflow design conditions once every five years. If these flow rates are found to differ from current design air flow rates by more than 10%, then these findings shall be brought to the attention of the Facility Manager. Repair as needed.

Basis: Recommended practice per ASHRAE Standard 62-1999 Ventilation for Acceptable Indoor Air Quality (Reference 10.4) Public Review Draft August 1996.

7.2.1.6 General

- 7.2.1.6.1** Before performing any modifications to a system, assess the full impact of the changes, DOE Facilities are required to establish administrative control programs to handle configuration changes resulting from maintenance, modifications, and testing.

Basis: Lessons Learned Operating Experience Weekly Summary 96-47(Reference 10.6). Undocumented Modifications Cause Ventilation Concerns. DOE 5480-19, Conduct of Operations Requirements for DOE Facilities Chapter VIII, "Control of Equipment and System Status" (Reference 10.7).

- 7.2.1.6.2** Provide inspection for lubrication and post maintenance testing of bearings on air handling systems.

Basis: Lack of periodic maintenance including lack of lubrication to the bearings, degradation of conditions to these components, and post-maintenance testing may cause the failure of components to the system which may be safety related. Lessons Learned Operating Experience Weekly Summary 96-10 (Reference 10.8). DOE-STD-1050-93 Guide to Good Practices For Planning, Scheduling, and Coordination of Maintenance at DOE Nuclear Facilities (Reference 10.9). DOE-STD-1039-93, Guide To Good Practices For Control Of Equipment And System Status (Reference 10.10).

- 7.2.1.6.3** Provide a lubrication control program to ensure that essential safety equipment is properly lubricated for optimal availability and reliability. Additionally, such programs should consider including non-safety related equipment requiring lubrication that is extremely expensive to replace or that involves substantial lead-time for replacement.

Basis: Proper lubrication including using maintenance procedures that include manufacturers requirements for lubricants and component alignment is vitally important in maintaining trouble-free operation and avoiding equipment damage. Lessons Learned Operating Experience Weekly Summary 98-06 (Reference 10.5). Lessons Learned Database Identifier: 1998-LA-LANL-ESH7-0004 Lubrication Control Concerns (Reference 10.11).

7.2.1.7 Predictive Maintenance

If feasible, incorporate predictive maintenance techniques such as vibration monitoring, detailed analysis of lubricating oil, thermographic assessments, and performance testing for valuable or mission critical equipment.

Basis: Predictive maintenance techniques can improve the reliability and availability of key components of an air handling system while reducing overall maintenance costs from reduced labor and parts support, improved reliability of equipment and the opportunity to establish better schedules and priorities for repairs before breakdown. Lessons Learned Operating Experience Weekly Summary 96-16 (Reference 10.12); DOE-STD-1052 Guideline to Good Practices for Types of Maintenance Activities at DOE Nuclear Facilities (Reference 10.9).

8.0 GUIDANCE

8.1 Operations Guidance

8.1.1 No implementing guidance available

8.2 Maintenance Guidance

8.2.1 Provided it has been reviewed and approved by FWO-SEM, an acceptable program for motor circuit evaluation may be found in the JCNNM Preventive Maintenance Instruction (PMI) Number 40-25-015 "Air Moving Equipment and Repair Program" (Ref. 10.13)

9.0 REQUIRED DOCUMENTATION

Maintenance history shall be maintained for fan and duct systems to include, as a minimum, the parameters listed in the Table 9-1 below:

Table 9-1 Documentation Parameters

MAINTENANCE HISTORY DOCUMENTATION PARAMETERS				
PARAMETER	ML 1	ML 2	ML 3	ML 4
Maintenance Activities				
Repair / Adjustments	X	X		
PM Activities	X	X		

Equipment Problems				
Failure Dates	X	X		
Failure Root Cause	X			
Inspection Results				
Inspection Date	X	X		
SSC Condition	X	X		

Basis: Documentation of the parameters listed in Table 9-1 above satisfies the requirements of LPR 230-07-00, Criteria 2, (Ref. 10.5) which states; "Maintenance activities, equipment problems, and inspection and test results are documented."

10.0 REFERENCES

- 10.1 OSHA Regulations 29 CFR 1910.147, General requirements for all machines.
- 10.2 Lessons Learned Database Identifier: 1998-CH-AMES-0001, Personnel Injury in Air Handling Unit
- 10.3 AMCA Publications 202-98 Fan Application Manual, Troubleshooting Section.
- 10.4 BSR ASHRAE Standard 62-1999 ASHRAE Standard Ventilation for Acceptable Indoor Air Quality.
- 10.5 Lessons Learned Operating Experience Weekly Summary 98-06, Inadequate Maintenance Procedures Could Have Resulted In The Failure Of An Exhaust Fan Bearing.
- 10.6 Lessons Learned Operating Experience Weekly Summary 96-47, Undocumented Modifications Cause Ventilation Concerns.
- 10.7 DOE Standard 5480-19 Conduct of Operations Requirements for DOE Facilities, Chapter VIII, Controls of Equipment and System Status.
- 10.8 Lessons Learned Operating Experience Weekly Summary 96-10, Maintenance Problem at Commercial Power Plant Causes Bearing Failure.
- 10.9 DOE Standard 1052-93, Guideline to Good Practices for Types of Maintenance Activities at DOE Nuclear Facilities.
- 10.10 DOE Standard 1039-93, Guide to Good Practices for Control of Equipment and System Status.
- 10.11 Lessons Learned Database Identifier: 1998-LA-LANL_ESH-7-0004, Lubrication Control Concerns.

- 10.12** Lessons Learned Operating Experience Weekly Summary 96-16, Predictive Maintenance Increase Reliability and Extend Component Life.
- 10.13** PMI Number 40-25-015 “Air Moving Equipment Maintenance and Repair Program”.
- 10.14** SMACNA Building Systems and retrofit Manual.
- 10.15** DOE O 4330.4B, Maintenance Management Program, Section 3.4.9.
- 10.16** LIR 301-00-02.3, Variances and Exceptions to Laboratory Operation Requirements.
- 10.17** Appendix G of the UC Contract.
- 10.18** DOE O 430.1A, Life Cycle Asset Management.
- 10.19** “The Air Conditioning/Refrigeration Toolbox Manual”, 1990, Teazabaum – Appendix B

11.0 APPENDICES

Appendix A: Summary of Recommended Maintenance Activities and Frequencies

Appendix B: Procedures for Belt Inspection, Alignment and Installation

Appendix C: Fan Start-up Check List

APPENDIX A

Summary of Recommended Maintenance Activities and Frequencies

	FREQUENCY						
	Monthly	Semi-annually	Seasonal	Annually	Bi-annually	Every 5 years[Equip Specific
COMPONENT							
Ventilation Units							
Bearing Lubrication	X						
Flexible Connection Inlet	X						
Flexible Connection Outlet	X						
Vibration Fan/Bearing/Belt	X						
Excess Noise	X						
Belt Tensioning		X					
Fan Section/Clean		X					
Proper Alignment of Fan		X					
Motor Lubrication/Moving Parts		X					
Proper Tensioning		X					
Belt Drive/Belts Wear		X					
Sheave Wear		X					
Air Filters		X					
Fan Wheel Fastened		X					
Wet Section/Internal Insulation		X					
Unsealed Fan Bearing Lubrication		X					
Fan Vibration/Vibration Isolators		X					
Fan and Motor Sheave Alignment		X					
Bearing Collar Fastened		X					
Dry Section of Units/gaskets, door		X					
Bearing/Motor Bracket Torque				X			
Fan Wheel Housing Obstruction				X			
Clean Fan Wheel & Shaft/Wear				X			
Fan Bearing Grease Line Conn.				X			
Unit Casing Corrosion				X			
Flow Surfaces for Cleanliness				X			
Gouge, Hole,Tear Blades/Housing				X			
Foreign Matter Imp/Housing/Duct				X			
Ductwork							
Ductwork Obstructions				X			
Bird Screens Clean				X			
Outdoor Air Intake Louvers Clean				X			
Supply Air Plenum					X		
Return Air Plenum					X		

APPENDIX A

Summary of Recommended Maintenance Activities and Frequencies

	Monthly	Semi-annually	Seasonal	Annually	Bi-annually	Every 5 years[Equip Specific
Drain Pans							
Condensate Drain Pan		X					
Inspect Drain Pans/Lines Clean		X					
Sloped Drain Pans		X					
Dampers							
Pneum/Elec Inop Damper Linkage				X			
Inlet Guide Vanes				X			
Actuated Damper Ops/obstructions				X			
Inlet/Discharge Dampers				X			
Pneum/Elec Controls				X			
Linkages Dampers/Guide Vanes				X			
Visually Inspect Operation				X			
Heavy Duty Indust. Grease/Lube				X			
Damper Linkage Set Screws				X			
Blade Adjustment				X			
Predictive Maintenance							
Vibration Monitoring							X
Lubricating Oil							X
Thermographic Assessments							X
Performance Testing							X
Airflow Measurement							
Designed Supply Airflow/Actual						X	
Designed Exhaust Airflow/Actual						X	
Designed Outdoor Airflow/Actual						X	
General							
Modification System Control							X
Periodic Lube/Post Maint Testing							X
Lubrication Control Program							X

Appendix B

“The Air Conditioning/ Refrigeration Toolbox Manual”, 1990

Author: Teazabaum

BELT INSPECTION AND ANALYSIS

Follow this procedure to inspect a belt:

1. Shut down the power switch and tag it: “Down for maintenance. Do not turn power on.” Lock the switch open.
2. Remove the guard and inspect it for wear or damage. Clean grease and debris from the guard to ensure good ventilation.
3. Notice the temperature. A belt that is too hot to touch just after the drive is shut down has problems. Find and correct the source of overheating before returning the drive to service.
4. Inspect the belt. Mark a starting point and work your way around, looking for cracks, nicks, frays, cuts, or unusual or uneven wear. Replace belts with excessive wear, cuts, or missing teeth.
5. Check alignment by removing the belt and laying a straight edge along the outside edges of both pulleys (see below). Misalignment will increase the chances for premature wear, instability, and turnover.
6. Inspect other parts of the drive: motor and pulley mounting, and housing.

ALIGNING A BELT

To prevent premature wear and failure, belt drives must be in proper alignment, with the shafts parallel and the pulleys in the same plane. If your inspection reveals a misalignment, corrective action is indicated. A belt can have either angular misalignment and/or parallel misalignment. (Misalignment can also result from a pulley that is damaged or improperly mounted.)

1. Angular misalignment can be detected by a long straight edge; a tape measure, string, or straight board can be substituted on a long drive (see Fig. K5b). In general, pulley alignment should be within 1/10 inch per foot (8.4 mm per meter) of the span between the pulleys. Correct a misalignment by loosening the mounting bolts and rotating one piece of equipment until both shafts are aligned. Then tighten the mounting bolts and check for parallel misalignment.
2. To check for parallel misalignment, use a square to show that each shaft is at 90° to the straightedge (see Fig. K5c). Correct by loosening pulley mounting screws and sliding the pulley until both edges of both pulleys line up to the straightedge.

INSTALLING AND TENSIONING A BELT

Belts must be properly installed and tensioned for good performance. Overtight belts will cause compressor seals to leak, and bearings and belts to wear prematurely. Loose belts will slip, heat up, and fail. New belts will stretch slightly, so manufacturers recommend

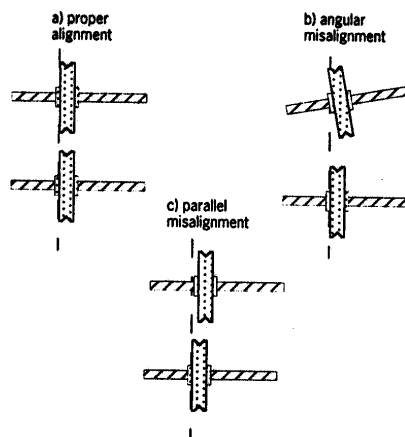


Fig. K5 Belt alignment

they be installed somewhat tighter than normal. Always check and retension a new belt after 4 to 24 hours of operation.

After performing the inspections suggested above, use this procedure to replace and tension a belt:

1. Check the number on the belt to order a replacement. If the number is illegible, measure the length (along the outside) before removing it from the drive. (Check the belt section later or use a gauge on the sheave to find the section.)
2. Loosen the motor mount and slide the motor toward the compressor to slack off the belt.
3. Remove the old belts without prying them.
4. Install the proper size belt. All belts should be replaced on a multiple drive to ensure that they pull equally.
5. Slide the motor back into position to tighten the belt.
6. Check and adjust alignment using the above procedure. Check tension by deflecting the belt at the midpoint between the pulleys. (Rotate multiple-belt drives by hand to seat them in the grooves and even out the tension before checking tension.) Although belt tension gauges are available, most mechanics deflect the belt manually and check that the belt moves a little without having excess slack. Use this rule of thumb: a force of 10 pounds (4.5 kg) should deflect a belt about 1/4 inch (1.3 cm).
7. Tighten motor mounting bolts to the proper torque.
8. After 4 to 24 hours of operation, recheck and readjust the tension.

**APPENDIX C
FAN START-UP CHECK LIST**

TAG _____ TA _____ BLDG _____ Room _____

DESCRIPTION _____

Performed By: _____ Date Performed: _____

Serial # _____ Manufacturer: _____

Model # _____

- ☐ Electrically Isolate and Lockout Fan
- ☐ Ensure starting torque is adequate for the speed and inertia of the fan.
- ☐ Inspect fan and ducts for debris that could be sucked into fan or dislodged.
- ☐ Check dampers for correct configuration.
- ☐ Turn fan impeller or wheel by hand to check for binding.
- ☐ Check belt tension and drive installation.
- ☐ Verify alignment on direct drive fans.
- ☐ Check that all nuts, belts, and setscrews are tight.
- ☐ Check for correct voltage supply and correct rotation.
- ☐ Upon startup, check for excessive vibration, unusual noises.
- ☐ Verify unusual design speed with a strobe light.

COMMENTS:

